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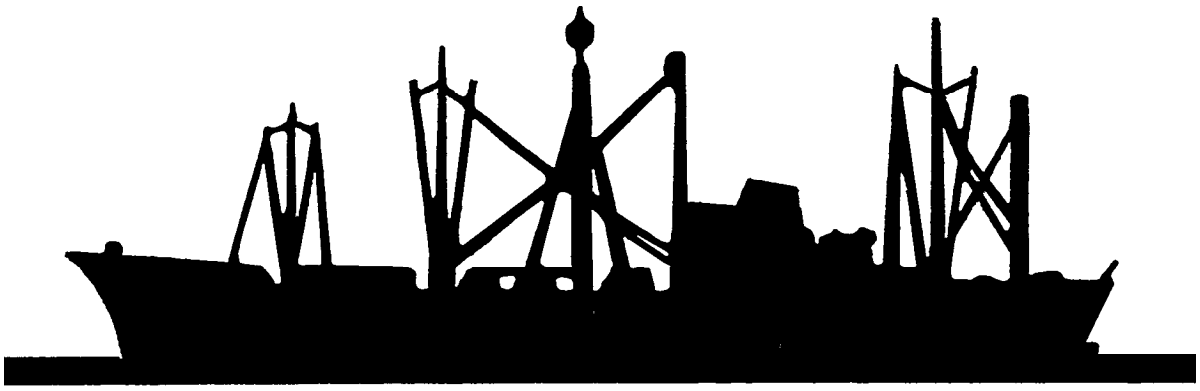

INSTITUTE FOR RESEARCH AND ENGINEERING FOR AUTOMATION AND PRODUCTIVITY IN SHIPBUILDING

IREAPS

JAPANESE SHIPBUILDING TECHNIQUES: SURFACE PREPARATION AND COATING--MATERIALS AND METHODOLOGY

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ABSTRACT

In this paper the Japanese and United States Shipbuilding Industries' coating systems and surface preparation and application methods are compared. The surface preparation and paint planning process as it relates to zone construction will be discussed in detail.

A comprehensive report on Japanese Shipbuilding, which will expand on *remarks given at this conference by Dr. Gerald Soltz and Mr. John Peart, should be available by late January, 1982.*

Those interested in receiving a copy of this report should contact: John W. Peart,. R & D Program Manager, Avondale Shipyards, Inc., P.O. Box 50280, New Orleans, Louisiana 70150.

Good morning .

The remarks I am about to make are based significantly on a recent trip to Japan, where John Peart of Avondale Shipyards and I toured a number of Japanese shipyards under the joint auspices of Avondale Shipyards and the Maritime Administration, as part of the National Shipbuilding Research Program.

Since returning from Japan, Mr. Peart and I have found that many people assume our trip was intended to learn all we could about Japanese efficiency -- an impression I'd like to correct, in order to set apart the real purpose of our trip from that much-abused term!

We're not against efficiency: but what could be worse, or less productive, than working very efficiently on something that shouldn't be done at all?

The factor we DID want to look at was the ability of the Japanese shipbuilding industry to combine high productivity with a notably respectable level of quality control.

"Efficiency" has something to do with this, of course: but so does technology; and operations planning; and work systems; and materials design; (and, of course, costs; and, inevitably, compromises).

The first factor I would like to focus on is PLANNING.

In Japanese shipbuilding, the PLANNING phase predominates. It is more wide-ranging, more methodical, more comprehensive, and worked out in much greater DETAIL than is usual in the U.S.

HOwcver , once the Japanese plan is set: it is MET.

What a Japanese shipbuilding plan calls for is what will actually be produced; and there wiLL be very few "surprises" to worry about. Instead, you can pretty much count on the end result, the completed vessel, being satisfactory within the range of the original plan.

one trick to this may be that often the Japanese PLAN itself is not grandiose, its goal nothing more earth-shaking than the production of a vessel capable of a reasonable service life.

This goal, however, is one the Japanese achieve.

Just what procedures are involved in achieving this goal? In the case of surface preparation and coating application:

1. All plates are primed automatically by machine, or supplied to the yard pre-primed by the steel mills.
2. Plates are then moved through normal cutting and welding procedures and built into sub-assemblies.
3. After sub-assembly, disc sanding of surfaces and wire brushing of welds is carried out. The resulting surface preparation will be about the best reasonably obtainable from mechanical cleaning procedures. The surface will be less than a top or "ideal" grade; but within its grade it sets a sulid and respectable standard. It would be missing the point to observe that better results might have been obtained with sand blasting or sand sweeping; because we are talking about a Japanese STANDARD surface preparation plan, which simply doesn't normally call for those techniques.

This type of standard surface preparation, by the way, is sometimes referred to as ISC-B, where disc sanding and wire brushing procedures are carried out in way of burned areas. Here, too, the standard procedures account themselves very well, normally removing all rust and ship primer in way of burned areas.

After wire brushing and disc sanding as Standard Surface Preparation, what follows as Standard Coating?

A single coat of coal-tar epoxy is normally used in ballast tanks; additionally, in the case of ballast tanks, striping of edges and ratholes is standard in some Japanese yards, but not in all cases.

In addition to standard surface procedures, the Japanese also offer capability for higher-quality surface preparation of cargo tanks, and in some cases ballast tanks, when this premium quality preparation is requested by a shipowner. In such a case:

1. Disc sanding and wire brushing phase out, in favor of sand sweeping and/or sand blasting;
2. Full striping replaces edge striping;
3. Extra coats of paint application are specified beyond "critical areas" only;
4. Some "customization*' of materials, work, or design may be designated (as, segregated product tanks.

Processes described so far are normally carried out in a three-stage procedure:

1. Overhead tanks blasted and primed to about $1^{1/2}$ meters above bottom;

2. Stripe coats and top coats applied to these upper primed surfaces;

3. Staging used to reach these upper tank areas is then removed, and the lowest 13 meters of tanks are blasted, primed and coated.

These three stages are generally carried out in several tanks simultaneously, by the way -- with work operations planned so that the staging can be used in, or moved from, one tank to another sequentially: a sensible plan for efficient use of equipment.

In the case of this higher-standard surface preparation, the owner will of course pay a premium price for the upgraded materials and escalated procedures criteria he identifies.

It's sometimes said that the American MINIMUM shipbuilding standards are higher than those in Japan; however, the attention, precision and sophistication they bring to their highest-criteria shipbuilding plans would seem to indicate that their MAXIMUM standards can be well above ours.

One feature of the Japanese "Maximum Standard" which ought to be mentioned is that it is accomplished almost exclusively by sub-contractors -- specialists in coating procedures.

However I don't mean to set up an absolutely rigid distinction between a Japanese "Standard" shipbuilding plan and one that is more exacting (that I 've just referred to as "Maximum Standard"). The distinction, while it exists, is not absolute.

The "Maximum Standard" that the Japanese can produce also hints at a flexible capability that can be used at times to selectively upgrade the "Standard" shipbuilding plan.

For example: while the "Standard" plan for ships' coating procedures in Japan has a number of compromises compared to what could be obtained in an overall "Maximum" shipbuilding plan, a Japanese shipyard may well designate critical areas WITHIN A "STANDARD" SHIPBUILDING PLAN -- but give these critical areas the benefit of "Maximum," or upgraded treatment.

In "critical" tanks, for instance, careful grinding down of all sharp edges precedes coating, in order to eliminate coating failure potential at those edges. In addition to rough edges, all sharp surfaces are also ground smooth.

In tanks designated for high-performance coating applications, pre-primed surfaces will be re-blasted to at least an SA 2.5 (and in face the results approach SA 3.0) throughout the tank before the blasted surfaces are then re-coated with holding primer of approximately 50-microns thickness.

Other features of the Japanese "Maximum Standard" shipbuilding plan:

1. Some system of dehumidification is normally used throughout these blasting and coating procedures;
2. During blasting stages, at least one of the major Japanese sub-contracting firms uses only reusable steel shot, rather than expendable grit. Since this reduces dust problems and materials costs at this stage of surface preparation, the particular sub-contractor had reason to be well-satisfied with the results obtained.

Where coating materials are concerned, the Japanese have recognized the importance of choosing a good pre-construction primer, since a well-selected primer is crucial in achieving both reasonable coating standards, and high productivity. It follows, then, that there are logially coating materials SPECIFICATIONS, or specific qualities Japanese shipbuilders find desirable in pre-construction primers. These qualities include:

- Ease of application
- Optimal handling time
- Quick hard-dry time (l-4 minutes)
- Anti-corrosivity (7-9 months)
- Good adhesion to steel substrate
- High resistance to solvents and chemicals
- Weldability (Should not generate pits or blowholes or affect strength of weld)
- Reasonable frame cutability (Should not slow cutting processes)
- Heat resistance (Minimally damaged by cut/we1d processes)
- Low toxicity, few polluting agents (No heavy metals)
- Flammability safety
- Reasonable cost

In Japan, by the way, we observed that pre-construction primers and top coats are developed by paint companies in response to requests from the shipyards! This user-supplier relationship seems to result from a closer, more integrated working arrangement than is normally seen between U.S. shipyards and American paint companies. The Japanese way of doing it, however, would seem to offer a number of obvious advantages for shipbuilding productivity.

What is the “bottom- line” result of the Japanese system where shipbuilding productivity is concerned?

Methods discussed here have enabled Japanese to reduce the man-hours required per square meter of surface prepared and coated to less than .l man-hour per square meter.

Maximum time normally required was about .4 man-hours per square,meter (in slop tanks).

-- Overall average man-hours required for the “Standard” shipbuilding plan varied between -05 and .l man-hours per square meter throughout a given vessel.

I feel strongly that the issues just outlined certainly call for more in-depth examination: all phases looked at in more detail; key processes quantified by cost analysis; and the overall demonstrable utility of Japanese and American shipbuilding systems further compared.